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A COMPARISON OF ADMINISTRATION PROCEDURES
FOR THE REY-OSTERRIETH COMPLEX FIGURE:
FLOW-CHARTS VS. PEN-SWITCHING

BY

JESSICA SOMERVILLE

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
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IN
PSYCHOLOGY

THE UNIVERSITY OF RHODE ISLAND

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ABSTRACT

The Rey-Osterrieth Complex Figure (ROCF) is commonly used to assess visuospatial skills, visuoconstruction, visual memory, and executive functioning. In order to capture the sequential process used while drawing the figure, the order of pen strokes needs to be recorded. Two traditional methods are used to record this information, the flow-chart method and the pen-switching method. Although it has been suggested that pen-switching may interfere with performance, to date, no research has been conducted to assess whether ROCF performance significantly differs due to administration method. As part of routine neuropsychological evaluation, 100 inpatients and outpatients were randomly assigned to either administration method. The Boston Qualitative Scoring System (BQSS) was used to qualitatively assess any differences between methods. Additionally, BQSS quantitative summary scores and the 36-point scoring system were used. Results showed essentially no differences between methods using either the BQSS or the 36-point system. Unexpectedly however, the flow-chart group performed significantly worse than the pen-switching group on Copy Cluster Placement, Copy Planning, and Copy Fragmentation. Flow-charts also took significantly longer to score, though both procedures took the same amount of time to administer. Contrary to expectation, pen-switching did not unduly distract patients or negatively affect ROCF performance. In fact, pen-switching appears to be easier to administer, score, and may possibly contribute to optimal patient performance.

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PREFACE

This master's thesis, prepared in standard form, is submitted in partial fulfillment of the requirements for the MA degree in Psychology. It addresses an issue in the area of neuropsychological assessment.

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INTRODUCTION

The Rey-Osterrieth Complex Figure (ROCF) (Rey, 1941; Osterrieth, 1944) (Appendix A) is commonly used by neuropsychologists in both clinical and research settings as a measure of visuoconstructional and visuospatial skills, as well as visual memory (Knight & Kaplan, in press; Knight, Kaplan, & Ireland, 1994). Additionally, information regarding executive functioning (e.g., planning, organization, perseveration) can also be assessed by examining the process or strategy a subject employs while copying and recalling the figure (Somerville, Tremont, & Stern, 1999; Stern & Prohaska, 1996). Although many examiners do not record process information, having their patients use just one black pen while drawing the figure, there has been a growing interest in quantifying the qualitative aspects of ROCF performance (Troyer & Wishart, 1997).

In order to capture the sequential process used while drawing the figure, the order of pen strokes needs to be recorded by the examiner. Two traditional methods are used to record this information, the flow-chart method and the pen-switching method. The stroke-by-stroke flow-chart method involves reproducing the subject's drawing on a separate sheet of paper as the subject draws the figure. The subject is given one pen which is used to copy the entire figure without interruption. On the flow-chart, the examiner orders each pen stroke with numbers and uses arrows to note the direction of each line drawn (Lezak, 1995; Spreen & Strauss, 1998). An example of a flow-chart is depicted in Appendix B. Alternatively, four to six different colored markers are typically used with the pen-switching method. The pens are quickly switched with the subject at certain intervals, usually when the subject completes a section of the drawing (Lezak, 1995), or at specified transition points, such as after the major configural elements are

completed or when a fragmentation occurs (e.g., Stern et al., 1999). Some approaches recommend switching at regularly timed intervals, such as every 30 seconds (Bernstein & Waber, 1996); however, this is not recommended with some scoring systems because it provides little information regarding critical transition points that may occur within the time interval (Stern et al., 1999). Appendix C demonstrates a ROCF drawn with the pen-switching method.

According to some authors (Bernstein & Waber, 1996; Meyers & Meyers, 1995; Lezak, 1995; Stern et al., 1999), there appears to be advantages and disadvantages to both administration systems (i.e., flow-chart, pen-switching) for the ROCF. For example, Meyers and Meyers (1995) state in their manual for the *Rey Osterrieth Complex Figure Test and Recognition Trial*, that there are several disadvantages to the pen-switching method:

First, clinical experience suggests that some respondents, especially those with moderate-to-severe brain dysfunction, are overly distracted by the requirement to switch markers. The ability to switch markers easily may also be influenced by impaired fine-motor control, depth perception, and so forth . . . Switching markers also takes additional administration time, making it problematic given the finding that the time it takes to copy the stimulus figure discriminates between brain-injured patients and normal subjects (Meyers & Lange, 1994) (p. 7).

Stern and colleagues state similar advantages to the flow-chart method in their scoring manual for the ROCF, *the Boston Qualitative Scoring System (BQSS)* (Stern et al., 1999):

. . . a flow chart may be more accurate and complete than colored markers in depicting the order of pen strokes. Furthermore, the use of a flow-chart eliminates the risk of any bias or distraction introduced by the examiner when switching markers. The decision as to which method to use is, in part, based on characteristics of the respondent, and in part, based on examiner preference. With regard to respondent characteristics, colored markers should be avoided with individuals who are either very easily distracted, who are susceptible to “stimulus pull”, or who display other clinical difficulties which could result in undo bias by switching markers (p. 18).

However, unlike Meyers and Meyers, Stern and colleagues also suggest that pen-switching may have its own advantages, such as providing the scorer with “an immediate and rich visual record of the order of pen strokes” and another is that “many examiners find it more difficult to keep track of the production when they are drawing a flow-chart” (Stern et al., 1999, p. 18). One method is not suggested over the other in the BQSS approach, and instead, examiners are instructed to base their decision on characteristics of the patients and their own preference.

The Developmental Scoring System for the Rey-Osterrieth Complex Figure (DSS) (Berstein and Waber, 1996) specifically promotes the pen-switching method. The authors state that this method allows an examiner to visually inspect and compare across protocols, which can be clinically useful. It is also possible that this visual record may facilitate scoring, because a flow-chart needs to be “dissected” stroke-by-stroke in order to examine the organization of the drawing. In contrast, they point out that the colors of a

pen-switched administration allow the planning and fragmentation of a production to “pop out” visually to the scorer, possibly making scoring easier and quicker.

The suggested ease of pen-switching administration, scoring, and interpretation would only be useful if pen-switching does not distract the patient or otherwise affect the patient’s performance. Patients referred for neuropsychological examination may exhibit deficits in various aspects of attention and/or executive functioning. Therefore, the constant switching of colored pens may not only be distracting, but may also result in “stimulus pull,” disinhibition, impulsivity, utilization behavior, and difficulties with planning, organization, fragmentation, and response set maintenance and shifting (e.g., Cummings, 1993; Gershberg & Shimamura, 1995; Kimberg, D’Esposito, & Farah, 1997; Lhermitte, Pillon, & Serdaru, 1986; Matteson & Levin, 1990; Miller, 1992; Starkstein & Robinson, 1997; Stern and Prohaska, 1996; Stuss & Benson, 1986; Varfaellie & Heilman, 1987). For example, the interruption of pen-switching may exacerbate difficulties with response set maintenance and shifting when patients direct attention to the drawing, to the examiner handing the pen, to the pen, and then back to where they left off in the drawing sequence. Also, the pen itself may “pull” some patients and take their attention away from the task, getting them off-course. The interjection of new stimuli and demands during the task may also exacerbate problems with disinhibition. It is, therefore, quite possible that completing a ROCF while pen-switching requires more executive control and intact attentional skills than completing one in which the patient is confined to one pen and the task at hand. Consequently, the production may become more fragmented and poorly organized. A haphazard production typically violates the overall gestalt of the figure and may result in lower accuracy scores due to the distortion that can result from

misaligned elements and misplaced details (Stern & Prohaska, 1996). In addition, the use of poor strategy appears to negatively affect recall (Gershberg & Shimamura, 1995; Lezak, 1995; Morris, Ahmed, Sued. & Toone, 1993; Ringe, Frol, Saine, & Cullum, 1998), and, therefore, the distraction of pen-switching may, in turn, reduce recall as well.

The purpose of the current study was to examine whether the two traditional ROCF administration procedures, the flow-chart method and the pen-switching method, affect ROCF performance in a group of neurologically-impaired patients referred for neuropsychological examination. To our knowledge, this question has never been objectively examined. As stated above, it has been suggested by authors of ROCF scoring systems that the pen-switching method may distract some patients and/or place greater demands on executive abilities. If this were the case, it would be predicted that patients receiving this method would produce more fragmented and poorly planned productions that may also be less accurate. Moreover, it would also be predicted that recall would be affected by reduced initial organization in the copy condition. Performances on the two methods were compared using the traditional 36-point scoring approach (Lezak, 1995; Osterrieth, 1944), as well as with the BQSS. The BQSS was used because it allows for both a qualitative and quantitative analysis of the ROCF productions. In particular, scores developed to be sensitive to executive functioning were chosen to demonstrate whether pen-switching exacerbates executive deficits, and whether a production is inaccurate because of poor planning and fragmentation or because of other factors (i.e., neatness). The Immediate Retention (IR) and Delayed Retention (DR) Summary Scores of the BQSS, which quantitatively assess the amount of information lost between conditions, were also examined.

Therefore, the following study hypotheses were proposed:

1. Due to the proposed higher demand on executive functions, pen-switched ROCF productions were hypothesized to be more fragmented, more poorly planned, and less organized than the flow-chart productions. Additionally, they should be more perseverative, less neat, more confabulated (in the delay conditions), as well as more expanded (both horizontally and vertically) than flow-chart productions. These findings should be present in all three conditions of the ROCF (Copy, Immediate, and Delay), except the Confabulation score, which should only be reduced in the delay conditions
2. The effects related to executive demands (Hypothesis #1) were proposed to indirectly result in reduced accuracy and placement of the ROCF elements (Configurals, Clusters, Details) within the Copy condition. In addition, the delayed productions in the pen-switching group should also be recalled in a less accurate and poorly placed manner.
3. The poorer executive scores in the pen-switching group (Hypothesis #1) should also indirectly affect the amount of information recalled, in both the Immediate and Delay conditions. Therefore, Presence scores (for Configurals, Clusters, and Details) in the recall conditions should be lower in the pen-switching group, as should the summary scores: Immediate Presence and Accuracy (IPA), Delayed Presence and Accuracy (DPA), Immediate Retention (IR), and Delayed Retention (DR) should also be lower in the pen-switching group compared to the flow-chart group.

METHOD

Participants

Participants included inpatient and outpatient neurologic and neuropsychiatric patients referred for neuropsychological evaluation at the neuropsychology service of a large urban academic medical center. Prior to the examination, subjects were randomly assigned to one of two groups, the pen-switching group or the flow-chart group. It was determined that a sample size of 50 per group would be necessary based on a medium effect size, power of .80, and alpha set at .05 (one-tailed) (Lipsey, 1990). A total of 100 patients (43 inpatients and 57 outpatients) were examined; 47 received the flow-chart method and 53 received the pen-switching method. The two groups did not significantly differ in sex, age, handedness, race, education, work status, occupational category, and marital status (Table 2). The sample included a wide variety of diagnostic groups, including, dementia (27%), traumatic brain injury (17%), stroke/cerebral vascular disease (14%), psychiatric disorder (9%), multiple sclerosis (6%), brain neoplasm (4%), diabetes (4%), cognitive disorder NOS (3%), epilepsy (3%), and other neurologic/medical disorder (e.g., meningitis, hydrocephalus, anoxia) (13%). Each diagnostic category was equally represented in both groups, as was duration of illness.

Materials

The copy, immediate, and delay conditions of the ROCF (Rey, 1941; Osterrieth, 1944) were scores using the BQSS (Stern et al., 1999). A major advantage to using this scoring system is its ability to assess several key qualitative features of the ROCF production. It is also the most comprehensive qualitative scoring system available for the ROCF, with 17 qualitative ratings per condition and 5 quantitative summary scores

(Table 1). The BQSS has been normed on about 500 adults, aged 18-94. Interrater reliability studies have demonstrated that the majority of scores have excellent reliability (Stern et al., 1994; Stern et al., 1999). The BQSS also appears to have good discriminant validity, as was demonstrated with Attention Deficit Hyperactivity Disorder (ADHD) in adults (Schreiber, Javorsky, Robinson, & Stern, in press) and children (Cahn, Marcotte, Stern, Arruda, Akshoomoff, & Leshko, 1996), and discriminating detoxified alcoholics from controls (Dawson & Grant, 2000) and traumatic brain injured patients from normal controls (Javorsky, Rosenbaum, & Stern, 1999). BQSS scores have also been shown to discriminate effectively between patients with Alzheimer's dementia and ischemic vascular dementia (Javorsky & Stern, 1999), and between Parkinson's dementia, Alzheimer's dementia, ischemic vascular dementia, and controls (Freeman et al, in press). The BQSS Summary Score, Copy Presence & Accuracy (CPA), also has excellent convergent validity with the traditional 36-point summary score (Stern et al., 1999).

In addition to measuring other qualitative features of visuoconstructive skills and visual memory, four of the BQSS' 17 scores (Planning, Fragmentation, Neatness, and Perseveration) and the Organization summary score were developed to be sensitive to executive dysfunction. Somerville et al. (1999) investigated the convergent validity between the BQSS' executive functioning scores with scores of other standardized neuropsychological tests commonly believed to measure executive functioning. The study found that the BQSS scores developed to be sensitive to executive functioning were significantly related to performance on traditional executive measures (e.g., Wisconsin Card Sorting Task, Trail Making Test, Controlled Word Association Test, Similarities

Subtest of the Weschler Adult Intelligence Scale), and that the strengths of the relationships were quite similar to the relationships found among the traditional executive tests. In addition, groups of patients with either intact, mild, or severe executive dysfunction were differentiated using the Organization summary score.

The BQSS divides the ROCF into three hierarchically arranged elements (i.e., Configurals, Clusters, Details) (Stern et al., 1999) each of which are scored according to their presence, accuracy (for Configurals and Clusters), and placement (for Clusters and Details). Scores range from a poor score of 0 to a good score of 4. In addition, several other scores are based on the entire production (e.g., fragmentation, planning, horizontal expansion). The following BQSS scores represented the dependent variables under investigation: Configural Accuracy, Cluster Accuracy, Cluster Placement, Detail Placement, Fragmentation, Planning, Neatness, Perseveration, Confabulation, Horizontal Expansion, and Vertical Expansion. In the recall conditions, Configural Presence, Cluster Presence, and Detail Presence were also examined. The first four variables were chosen in order to examine whether pen-switching affects the accuracy and placement of the ROCF elements. Previous research has suggested that Accuracy and Placement scores are sensitive to executive dysfunction (Cahn et al., 1996; Silva, et al., 1995; Suhr et al., 1995). The quantitative Summary Score, Copy Presence and Accuracy (CPA), was analyzed in order to see if the combination of these scores (see Table 1) results in group differences. The Planning, Fragmentation, and Perseveration variables (as well as the Organization Summary Score) were also chosen because these scores appear to be valid measures of executive dysfunction (Somerville et al., 1999). It has also been suggested that executive impairment (particularly impulse control and disinhibition) can affect

Neatness, Confabulation (in the delay conditions) (Stern et al., 1999), and Expansion scores (Cahn et al., 1996), and therefore these scores were also included. The delayed condition presence and accuracy summary scores (Immediate Presence and Accuracy, IPA; Delayed Presence and Accuracy, DPA), were chosen to examine whether pen-switching impacts the amount of information (number of elements present) recalled. Other BQSS variables were excluded from all analyses (e.g., Rotation, Asymmetry) because they were not apriori assumed to be affected by pen-switching. Additionally, the quantitative summary scores, Immediate Retention (IR), and Delayed Retention (DR) were also examined to assess the amount of information lost between conditions. Finally, the Organization summary score was chosen because it appears to be a valid overall measure of executive dysfunction (Somerville, Tremont, & Stern, 1999). BQSS summary scores are described in Table 1. In addition to the summary scores, the qualitative Confabulation score was also assessed in the immediate and delayed conditions.

In addition to the BQSS, the traditional 36-point scoring system was used. Each production was scored using the specific criteria as outlined in Duley et al. (1993).

Procedures

Patients were randomly assigned to receive either the flow-chart or pen-switching method prior to their neuropsychological evaluations. Evaluations were conducted by either a licensed clinical neuropsychologist (G.T.) or one of two post-doctoral fellows in clinical neuropsychology (D.J., H.W.). As part of the routine clinical examination, information was gathered on each patient regarding recent events leading to the current injury or illness, previous medical and psychiatric history, as well as educational, work,

and social history. This information was gathered from the medical record, family members, and when appropriate, from the patients themselves.

The BQSS professional manual provides detailed instructions for the administration of the ROCF for both the flow-chart and pen-switching methods (Stern et al., 1999). All clinicians received intensive training to standardize the assessment protocol, as outlined in the BQSS manual. Patients assigned to the flow-chart method were given one black felt-tipped marker to copy the figure, and the examiner reproduced the patient's drawing on the BQSS response sheet (or on a plain paper when necessary, i.e., the figure was extremely distorted). Examiners used arrows to indicate the directionality of a line drawn by the patient, and numbered each line to indicate the sequence of pen strokes (see Figure 1). In the pen-switching condition, three to six colored felt-tipped markers (i.e., black, blue, red, purple, green, pink) were used. Directly before giving the instructions, the pens were uncapped and set beside the stimulus. The pens were switched according to the guidelines suggested in the BQSS manual (e.g., after the first element is completed, when a Configural Element is fragmented), and the order of the pens were kept constant across subjects, and across conditions (copy, immediate, and delay).

All subjects received a copy condition, immediate recall, and 20-30 minute delayed recall. For both the flow-chart and pen-switching methods, administration times for each condition were recorded from the beginning of the presentation of the blank response form to the completion of the production. As part of routine neuropsychological assessment, other neuropsychological tests were given within the 20-30 minute time period that existed between the immediate and delayed recall conditions. In order to

avoid confounding the visual memory recall for the delayed condition, visuospatial and visuoconstructional tasks were not used as filler tasks. All ROCF productions were scored using the BQSS and the 36-point scoring system by a single post-doctoral fellow in clinical neuropsychology who has extensive scoring experience with both scoring systems. The scorer was kept blind to the specific hypotheses of this research study in an attempt to control bias in scoring.

RESULTS

BQSS Scores

In order to control for Type I error, a multivariate Hotelling's test was first conducted for the copy condition. The BQSS variables of interest in the copy condition (Configural Accuracy, Cluster Accuracy, Cluster Placement, Detail Placement, Fragmentation, Planning, Neatness, Perseveration, Horizontal Expansion, and Vertical Expansion) were the dependent variables in the analysis, and the administration method (i.e., pen-switching versus flow-chart) was the independent variable. Using a one-tailed test with the a priori prediction that the flow-chart group would perform better on these variables than the pen-switching group, there were no significant differences. However, an exploratory two-tailed analysis revealed that the T^2 test was significant, $F(10, 87)=1.963$, $p < .05$. Follow-up independent t -tests (Table 3) revealed that the pen-switching group scored significantly better than the flow-chart group on three BQSS variables, Copy Cluster Placement, Copy Fragmentation, and Copy Planning. There were no other significant between group differences.

Multivariate Hotelling's T^2 tests for the Immediate and Delayed Conditions were performed on the same variables as the Copy condition, plus the Presence scores

(Configural, Cluster, and Detail) and the Confabulation score, and neither test was significant.

To assess whether pen-switching in the Copy condition would consequently impact patients' productions in the delayed conditions, IPA, DPA, IR, and DR summary scores were assessed. These summary scores, along with the Organization summary score, were analyzed using independent t-tests, and the Bonferroni procedure was used to control for Type I error ($p < .05/5 = p < .01$). None of the Summary variables were significantly different. However, examination of the mean Summary scores indicated that for each of these variables, the pen-switching group performed better than the flow-chart group.

In addition to the parametric analyses described above, nonparametric Mann-Whitney U tests were also performed of the nature of the BQSS qualitative scores (i.e., some assumptions of parametric tests may be violated). Results of the Mann-Whitney U tests were nearly identical to the parametric tests, in that there were no significant group differences, after Bonferroni correction, and those variables that did approach significance were in the opposite direction to apriori prediction (the pen-switching group performed better).

36-point Scores

Using independent t-tests, there were no significant differences, across all three conditions, using the 36-point scoring system.

Administration and Scoring Times

In the Copy condition, administration times for both the pen-switching ($M=240$ seconds, $SD=110$ seconds) and flow-chart ($M=262$ seconds, $SD=141$ seconds) conditions

were not significantly different. However, scoring times (using the BQSS), did differ between the two groups. Flow-chart productions took significantly longer to score than pen-switched productions in the copy and immediate conditions. In the delayed condition, flow-charts also took longer to score than pen-switched productions, though this difference only approached significance. Table 4 depicts the means and standard deviations for the scoring times in all three conditions. There were no significant differences in scoring time for the 36-point scoring system, as would be expected as pen stroke order is not assessed with this method.

DISCUSSION

It has been suggested by authors of some ROCF scoring systems (Meyers & Meyers, 1995; Stern, 1999) that the pen-switching administration procedure may be overly distracting to patients, and, therefore, may negatively affect ROCF performance. Additionally, literature on executive functioning would suggest that the pen-switching method is more executively demanding due to increased likelihood of distractibility, stimulus pull, disinhibition, utilization behavior, and response set maintenance difficulties (e.g., Cummings, 1993; Gershberg & Shimamura, 1995; Miller, 1992; Stern & Prohaska, 1996). These views suggest that the added demands of pen-switching could consequently affect planning, organization, and fragmentation of the figure, as well as reduced retention on delayed recalls. Results of the current investigation indicate that patients who were interrupted by switching colored markers were no more likely to have poorly planned, fragmented, and disorganized productions than patients who used only one pen. Furthermore, the ROCF productions in the pen-switching condition were also no more inaccurate, messy, perseverative, or expanded than in the flow-chart condition. Finally,

the degree of confabulation and the amount of information recalled and retained, both immediately and over delay, was essentially equivalent for the two administration procedures. Quantitative summary scores (i.e., CPA, IPA, DPA) also demonstrated that the presence and accuracy of elements within the figure did not differ across conditions. When the figures were scored with the commonly used 36-point scoring system, again the results confirmed that the overall amount and quality (i.e., accuracy, placement) of information copied and recalled were not affected by administration procedure.

A study by Meyers and Lange (1994) found that copy administration time discriminated brain-injured patients from controls, and it was suggested in the Meyers and Meyers ROCF scoring manual (1995) that pen-switching may confound this finding by lengthening administration time. However, our study did not find any differences in administration time between the two procedures. Therefore, switching pens did not increase administration time, and should not affect interpretations based on length of time to complete a production. Although a time difference was not found in administration time, scoring time did differ between the two procedures when using the BQSS. In all three conditions, it took significantly more time to score a flow-chart production than a pen-switched one (an average of approximately two minutes more in the Copy condition). When scoring a flow-chart, the order and direction of pen-strokes is examined sequentially, thereby making qualitative scoring more laborious. The pen-switching method allows for a rich visual record of the strategy employed, including the degree of fragmentation and disorganization (Bernstein & Waber, 1996; Stern, 1999). This immediate visual representation appears easier for a scorer to examine and make scoring judgments, particularly with respect to keeping track of the order of pen-strokes

(i.e., planning). Finally, as would be expected, scoring time did not differ using the 36-point scoring system because qualitative information (e.g., order of pen strokes) is not assessed using this system.

The results of the current investigation suggest that either the pen-switching method or the flow-chart method can be used without significantly affecting ROCF performance. Some authors have stated that their “clinical experience” indicates that pen-switching should be avoided because it is distracting, and it can be influenced by certain neurologic conditions (e.g., impaired fine-motor control, depth perception) (e.g., Meyers & Meyers, 1995). However, our study failed to support this claim. Rather, we found that the pen-switching group tended to have higher scores than the flow-chart group in the majority (71%) of all qualitative scores assessed, including statistically significant differences on Copy Cluster Placement, Copy Planning, and Copy Fragmentation. In an attempt to explain this unexpected finding, we wanted to ensure that the two groups were comparable with respect to degree of cognitive impairment. An examination of Mini-Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975) scores on a subset of patients who received the MMSE (N=41) revealed no group differences (flow-chart [N=23], M=21.2, SD=6.9; pen-switching [N=18], M=21.9, SD=7.5). Therefore, we can only speculate other possible explanations as to why colored pens may actually facilitate a patient’s performance, instead of the assumed opposite. It is possible that colored pens make the task more engaging for the patient, which could enhance attention, concentration, and effort. Visualizing the production in an ordered color sequence could also provide structure, thereby promoting organization and facilitating planning. However, given the administration procedure of pen-switching

(e.g., switching after a fragmentation has occurred), this explanation is unlikely. Perhaps it is also possible that the pen-switching verbal instructions may raise patients' awareness about the recording of the process of figure. Stating that "the colored markers are only used so that I can remember how you're drawing the figure. . ." (Stern et al., 1999, p. 11) may result in patients actually paying closer attention to the way they are drawing.

The findings of the current study are based on a patient sample consisting of a wide variety of neurologic and medical disorders, including patients with conditions expected to result in executive and attentional impairments. Although these results are well-suited for generalization purposes, they do not tell us if certain conditions, disorders, or cognitive deficits may be differentially affected by administration procedure. Because pen-switching may particularly effect the performance in patients with significant executive impairment, this study should be replicated on a sample of patients with known frontal-systems dysfunction. Unfortunately, our data did not contain a large enough subsample of frontal lesioned patients for an exploratory analysis to this question (i.e., insufficient power). Future research could also shed light on the surprising trend of pen-switching possibly enhancing ROCF performance.

The ROCF can provide useful information in multiple areas of neuropsychological functioning (i.e., visuospatial skills, visuoconstruction, visual memory, executive dysfunction), and because of its utility, it remains a popular neuropsychological instrument (Knight & Kaplan, in press). Due to today's fiscal and time demands, it is essential to be sensitive to efficiency in assessment, without jeopardizing quality and comprehensiveness. Therefore, the present results suggest that for most practical purposes, examiners may wish to use the pen-switching method rather

than the flow-chart method because it is considered easier to administer (Stern et al., 1999), as well as quicker to score, and it may possibly promote the best effort from patients. It is important to note that flow-charts still remain useful when a detailed line-by-line representation of the figure is required (e.g., for some research purposes). However, the results of this study suggests that an examiner should not feel it is necessary to use flow-charts in order to obtain optimal performance from most patients.

Table 1. Brief Descriptions of the BQSS Qualitative Scores and Quantitative Summary Scores Used in the Present Study.

Presence (Configural, Cluster, and Detail)

Measures ability to attend to and process specific elements in copy condition and to recall them in the immediate and delayed recall conditions.

Accuracy (Configural and Cluster)

General assessment of visuoconstructional skill and visuoperceptual ability in the copy condition and adequacy of visual recall in the recall conditions.

Placement (Cluster and Detail)

Measures spatial functioning, judgment of angles, and spatial orientation.

Fragmentation

Measures integration of information (i.e., whether or not the individual elements are drawn as whole units).

Planning

Measures overall planning ability based on the order in which elements are drawn, placement on the page, placement within the figure, and overall integrity of the production.

Neatness

Rates how neatly the figure was drawn as evidenced by the number of wavy lines, gaps and overshoots, cross-outs, rounded corners, etc.

Vertical Expansion

Size distortion measured by placing a scoring template over the drawing to determine the degree of vertical expansion.

Horizontal Expansion

Size distortion measured by placing a scoring template over the drawing to determine the degree of horizontal expansion.

Perseveration

Measures the extent of recognizably inappropriate repetition. May take one of two forms: repetition of components within a cluster or replication of an element of the figure (Configural, Cluster, or Detail).

Confabulation

Rating of additions to the figure. May take one of two forms: an intrusion of a previous visuospatial task or a novel addition to the figure that is unrelated either to the original figure or to a previously administered visuospatial task.

Table 1 (con't.)

Presence and Accuracy (Copy = CPA, Immediate = IPA, and Delayed = DPA)

Unweighted arithmetic mean of Configural Presence, Accuracy, Cluster Presence, Cluster Accuracy, and Detail Presence. For the copy condition, it represents a global measure of visuo-perceptual accuracy and overall visuo-constructional ability. For the recall conditions, it represents the amount and accuracy of information recalled.

Immediate Retention (IR)

Measures the percent of information lost or gained from copy to immediate recall.

Delayed Retention (DR)

Measures the percent of information lost or gained from immediate recall to delayed recall.

Organization

Arithmetic sum of the copy condition Fragmentation and Planning scores, providing a more omnibus measure of organizational skills.

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Table 2. Demographic Variables for the Pen-Switching and Flow-Chart Groups.

<u>Demographic</u>	<u>Flow-Chart</u>	<u>Pen-Switching</u>
	<u>Means (SD)</u>	
Age	57.79 (20.70)	55.02 (17.89)
Education	12.91 (3.41)	13.78 (3.39)
	<u>Frequencies (N)</u>	
Gender	Male=23 Female=24	Male=30 Female=23
Handedness	Right=40 Left=6 Ambidextrous=1	Right=50 Left=0 Ambidextrous=3
Race	Caucasian=44 African American=1 Asian=2 Other=0	Caucasian=49 African American=1 Asian=1 Other=2

Table 3. Group Differences on BQSS Scores and 36-Point Scores Between the Pen-Switching (N=53) and Flow-Chart (N=47) Methods.

	Flow-Chart	Pen-Switching	
	Mean (SD)	Mean (SD)	t
Configural Accuracy	1.43 (1.23)	1.81(1.13)	-1.64
Cluster Accuracy	1.83 (1.11)	2.02 (1.12)	-0.85
Cluster Placement	2.36 (0.99)	2.74 (0.81)	-2.01*
Detail Placement	2.87 (1.11)	2.98 (0.98)	-0.53
Fragmentation	2.26 (1.17)	2.70 (0.99)	-2.05*
Planning	1.55 (1.27)	2.02 (1.08)	-1.98*
Neatness	1.77 (0.84)	1.60 (0.74)	1.03
Vertical Expansion	3.68 (0.66)	3.66 (0.73)	0.15
Horizontal Expansion	3.26 (1.22)	3.36 (1.08)	-0.45
Perseveration	2.94 (1.28)	2.85 (1.33)	0.33
36-Point Score	18.74 (7.27)	20.80 (6.20)	-1.53

Note. BQSS Scores range from 0 (very poor) to 4 (good). * $p \leq .05$

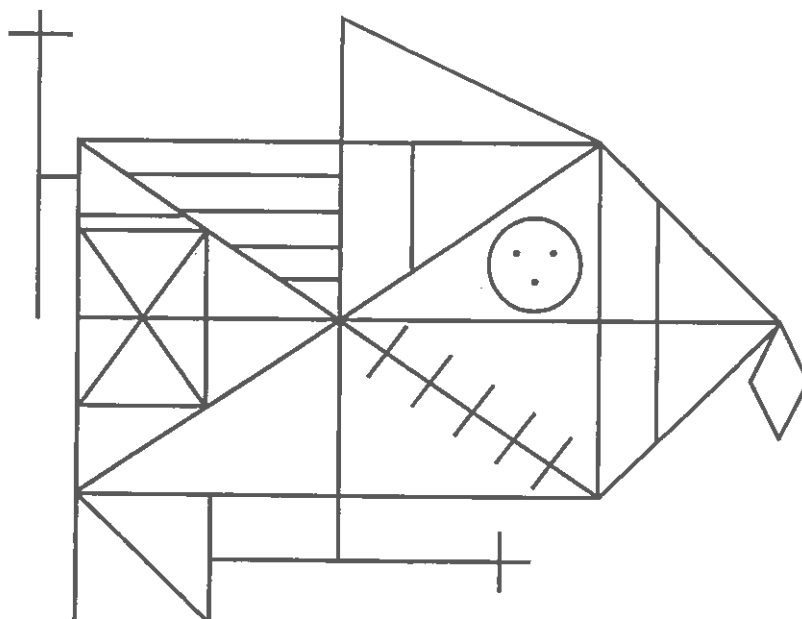
Table 4. Scoring Times Group Differences (in Seconds) Between the Pen-Switching (N=53) and Flow-Chart (N=47) Methods.

	Flow-Chart	Pen-Switching	
	Mean (SD)	Mean (SD)	t
BQSS			
Copy Condition	383 (114)	255 (47)	7.31**
Immediate Condition	225 (106)	174 (62)	2.90*
Delay Condition	194 (107)	158 (69)	1.99
36-Point Scoring System			
Copy Condition	132 (46)	134 (49)	-0.19
Immediate Condition	70 (39)	69 (37)	0.14
Delay Condition	52 (35)	54 (31)	-0.31

*p<.01; **p<.001

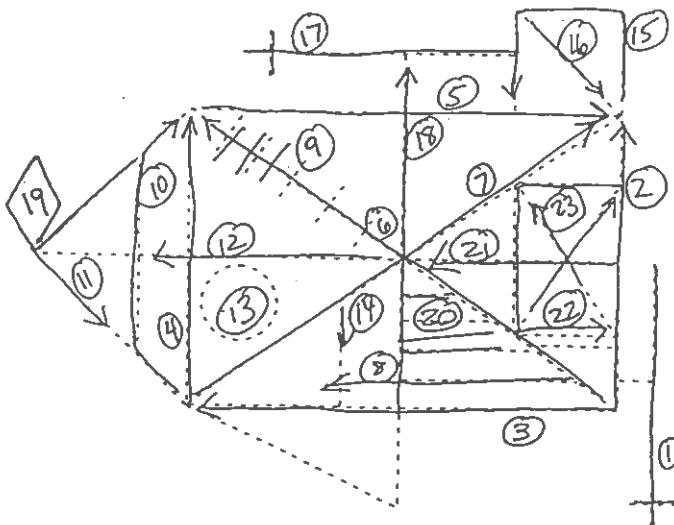
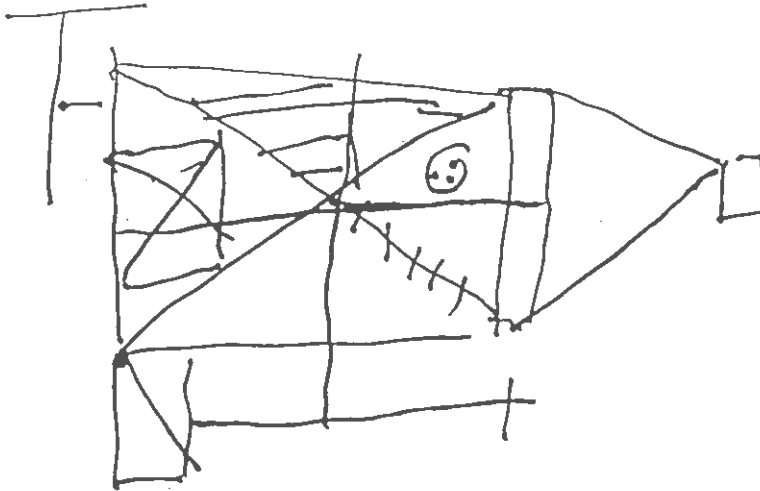
APPENDIX A

The Rey-Osterrieth Complex Figure (ROCF).



APPENDIX B

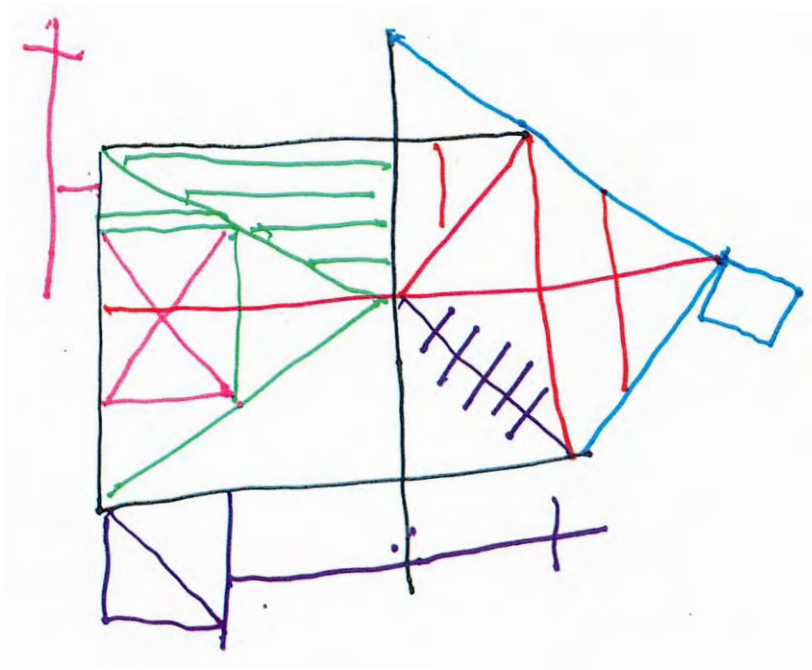
Example of a copy condition ROCF production (top) with corresponding flow-chart (bottom) from a male outpatient (78 years old, MMSE=27) with polycythemia.



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APPENDIX C

Example of a copy condition ROCF drawn with the pen-switching method from a male outpatient (80 years old, MMSE=26) with cerebrovascular disease.



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